ACE & GPM

Arthur Hou

NASA/GSFC

ACE SWG 19-20 June 2008

Global Precipitation Measurement (GPM) Mission

Specifically designed to unify and advance global precipitation measurements from dedicated and operational satellites for research & applications

GPM Low-Inclination Observatory (40^{o})

GMI (10-183 GHz)
LRD: Nov. 2014

- Enhanced "asynoptic" observations
- Improved sampling for near realtime monitoring of hurricanes and midlatitude storms

GPM CORE Observatory (65^{o})

DPR (Ku-Ka band)
GMI (10-183 GHz)
LRD: July 2013

- Precipitation physics observatory
- Reference standard for inter-calibration of constellation precipitation measurements

Partner Satellites:

GCOM-W, DMSP, Megha-Tropiques, MetOp-B, NOAA-N', NPP, NPOESS

Providing next-generation global precipitation products through

advanced active & passive microwave sensor measurements
a consistent framework for inter-satellite calibration (radiance & rain rates)
international collaboration in algorithm development and ground validation

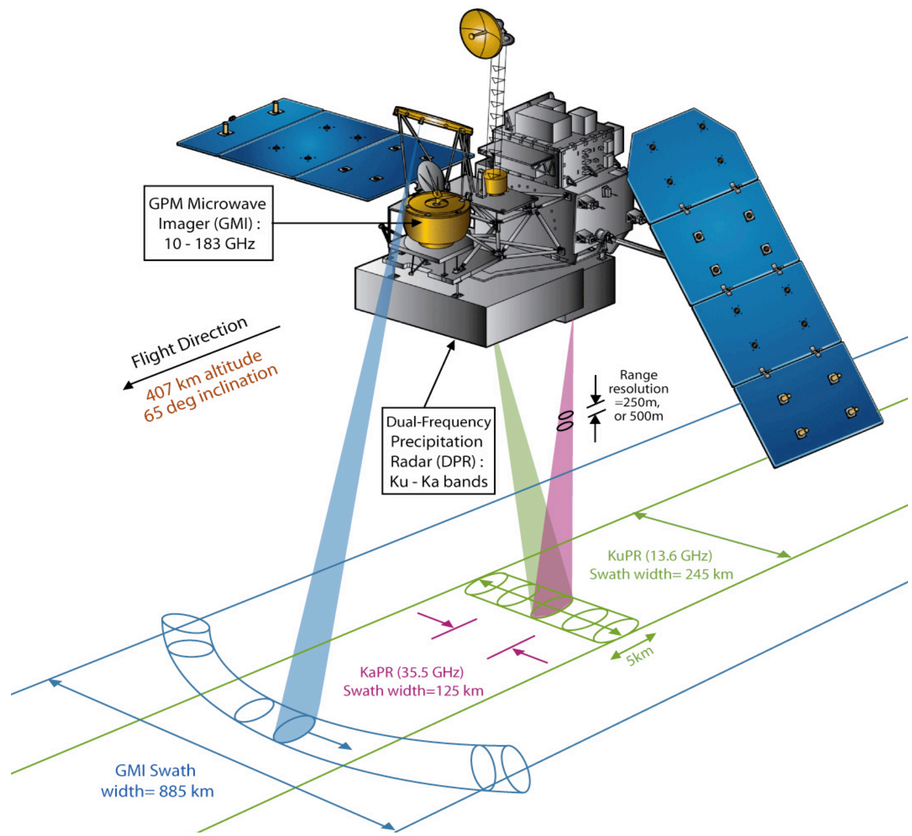
GPM Core Observatory Measurement Capabilities

Dual-Frequency (Ku-Ka band) Precipitation Radar (DPR):

- *Increased sensitivity (11 dBZ) for light rain and snow detection*
- *Better measurement accuracy with differential attenuation correction*
- *Detailed microphysical information (DSD mean mass diameter & particle no. density) & identification of liquid, ice, and mixed-phase regions*

Wide-Band (10-183 GHz) Microwave Imager (GMI):

- *High spatial resolution*
- *Improved light rain & snow detection*
- *Improved signals of solid precipitation over land (especially over snow-covered surfaces)*
- *4-point calibration to serve as a radiometeric reference for constellation radiometers*



Combined Radar-Radiometer Database

- *DPR & GMI together provide greater constraints on possible solutions to improve retrieval accuracy*
- *Improved cloud database for constellation radiometer retrievals*

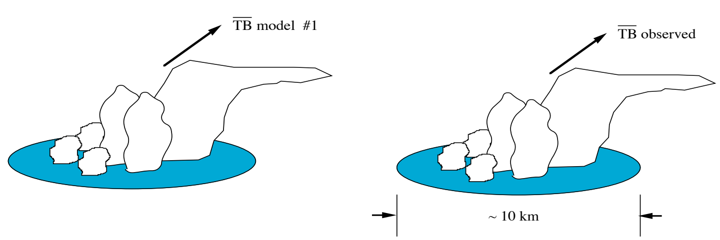
GPM Core as the calibration reference for constellation radiometers

- *Calibration of Level-1 constellation radiometric data using GMI as reference:* GMI is designed to ensure greater accuracy and stability by employing
  - *Encased hot-load design*
  - *4-point calibration for nonlinearity removal & backup calibration during hot-load anomalies*

- *Calibration of Level-2 rainfall data using DPR+GMI measurements:* Making combined use of GMI and DPR measurements to provide a common cloud/hydrometeor database for precipitation retrievals from the GPM Core and Constellation radiometers.

Physical precipitation retrieval: Matching observed T_b with those simulated from a prior cloud database within a statistical framework

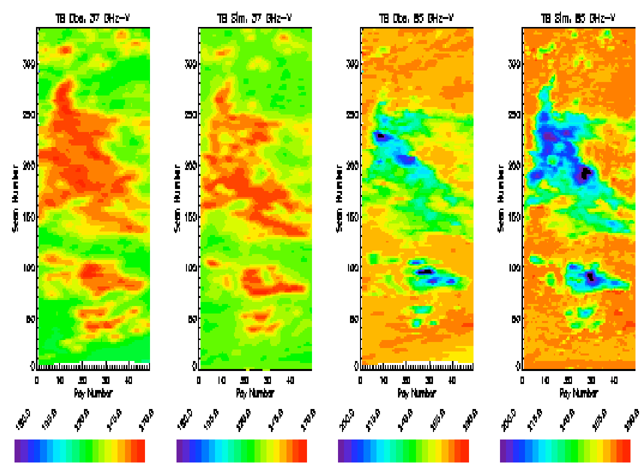
Simulated T_b *Observed T_b*



TRMM uses a model-generated database
GPM uses a combined DPR+GMI database

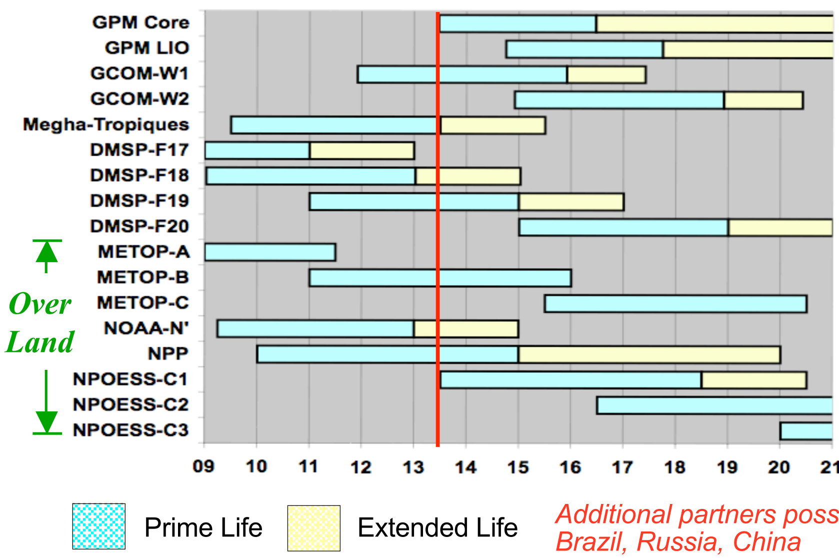
(ACE radiometer retrievals)

Simulated vs. observed TMI T_b



Baseline GPM Constellation Performance

GPM Core Launch



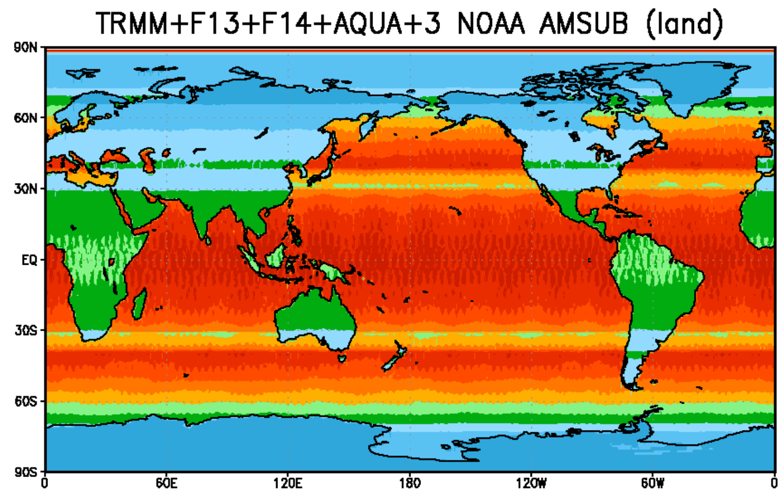
Additional partners possible: Brazil, Russia, China

	Average Revisit Time (hr)				
Year	2013	2014	2015	2016	2017
	Land				
Tropics	1.6	1.5	1.6	1.8	2.3
Extratropics	1.1	1.0	1.0	1.0	1.4
Globe	1.4	1.2	1.3	1.4	1.8
	Ocean				
Tropics	3.1	2.5	3.2	3.9	4.9
Extratropics	3.2	2.6	2.1	2.6	3.3
Globe	3.1	2.5	2.7	3.3	4.2
	Land and Ocean				
Tropics	2.6	2.2	2.7	3.1	4.0
Extratropics	2.3	1.9	1.6	1.9	2.5
Globe	2.4	2.0	2.1	2.5	3.3

1-2 hr revisit time over land

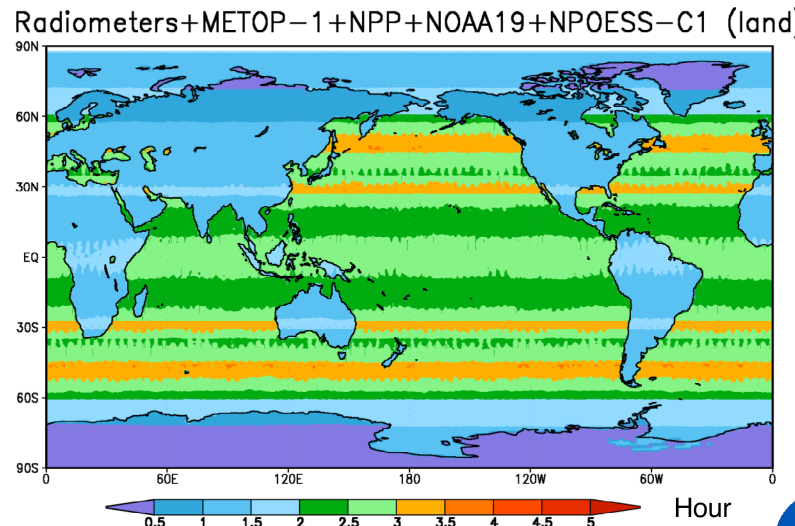
Current Capability

($\leq$ 3h over 45% of globe)



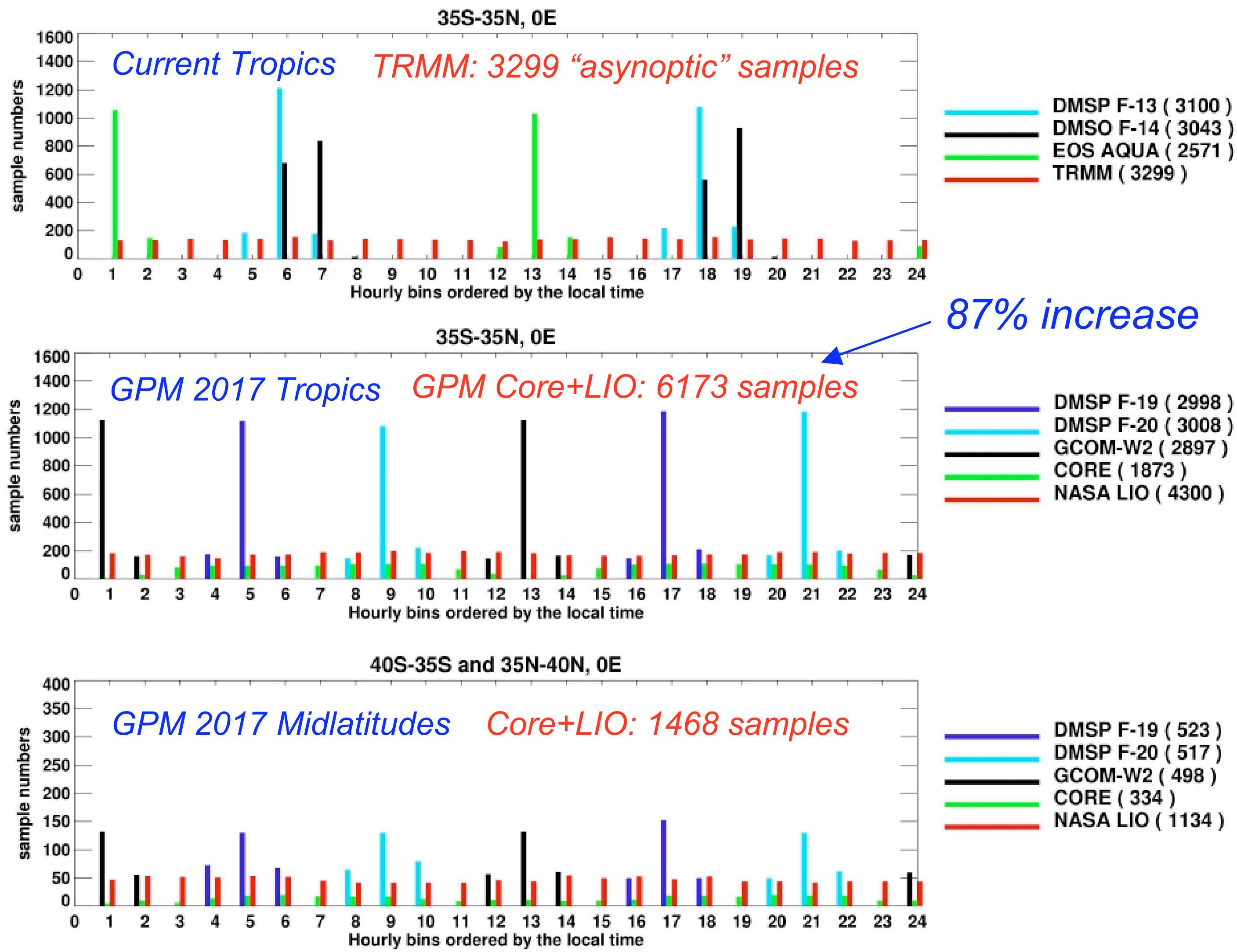
GPM (2015)

($\leq$ 3h over 92% of globe)



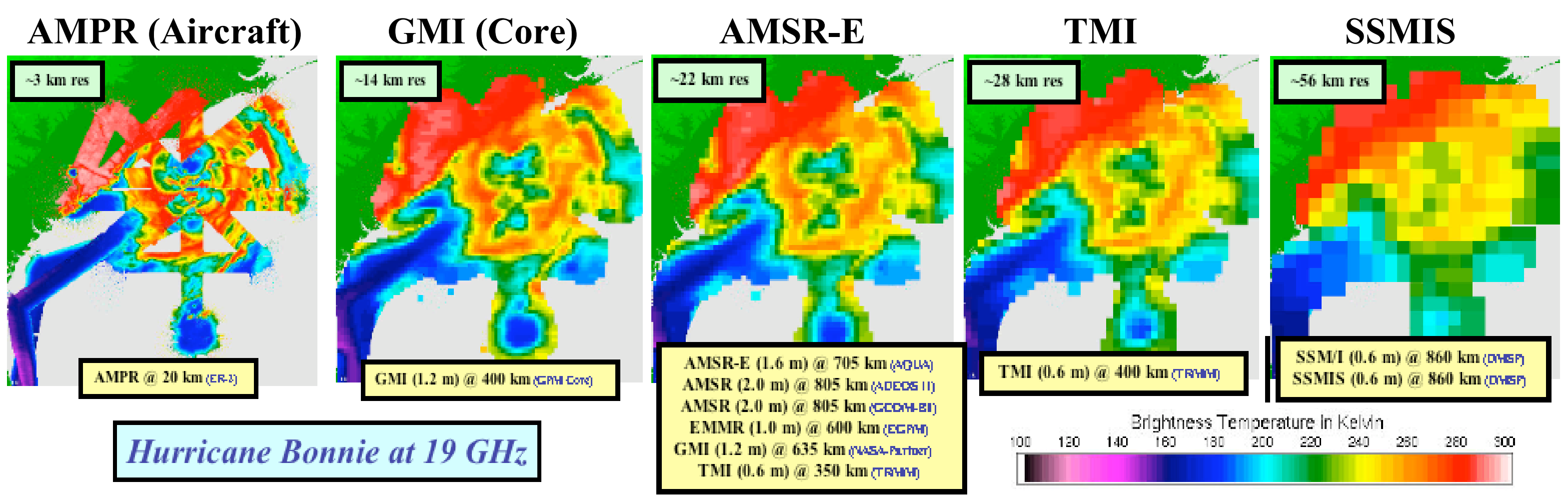
Sampling from non-Sun-synchronous orbits

Monthly Samples as a Function of the Time of the Day (1º x 1º Resolution)



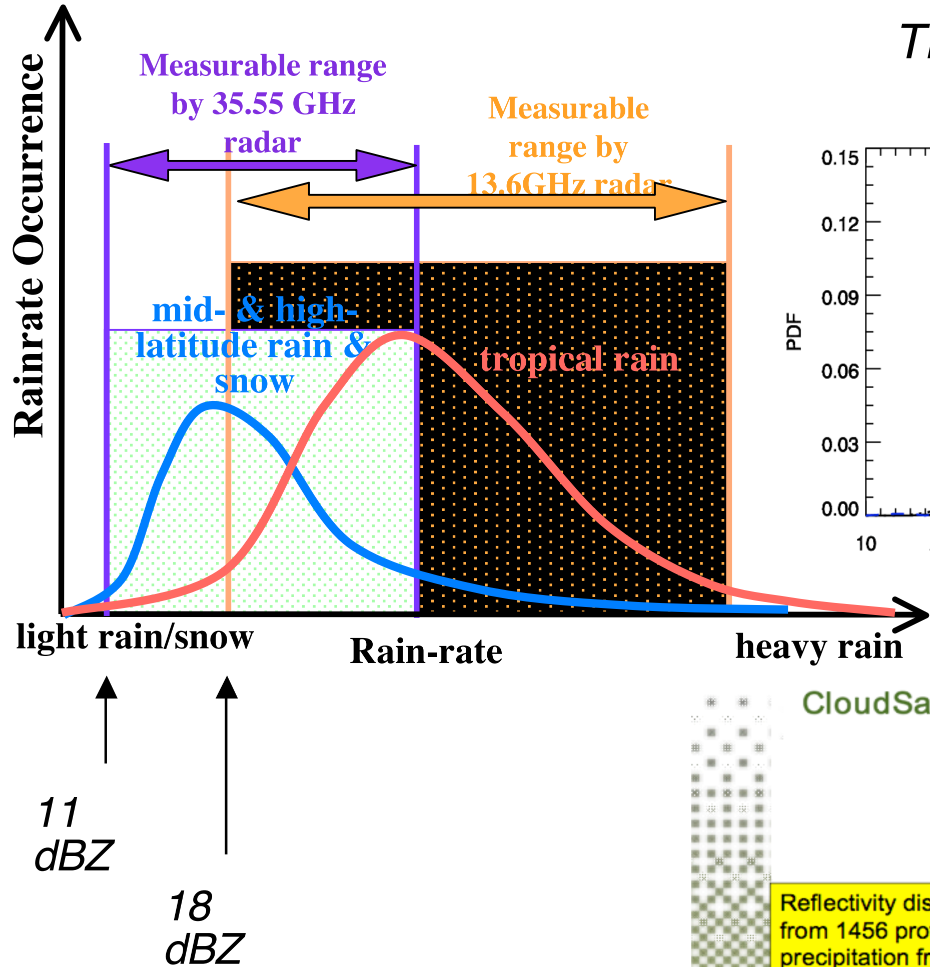
GMI uses a set of frequencies optimized over the last two decades to estimate heavy, moderate, and light precipitation over land and ocean.

- 10.65 GHz H&V (for the heaviest precipitation encountered in the tropics)
- 18.7 and 36.5 GHz H & V (moderate to light rain over ocean)
- 23.8 GHz (water vapor correction for other channels)
- 89.0 GHz (for heavy-to-moderate rain rates over land and convective/stratiform rain separation)
- 166 GHz (snowfall rates over ocean and light rain rates over ocean and land)
- 183 $\pm$3, $\pm$8 GHz channels (light rain rates and falling snow over snow-covered surfaces)



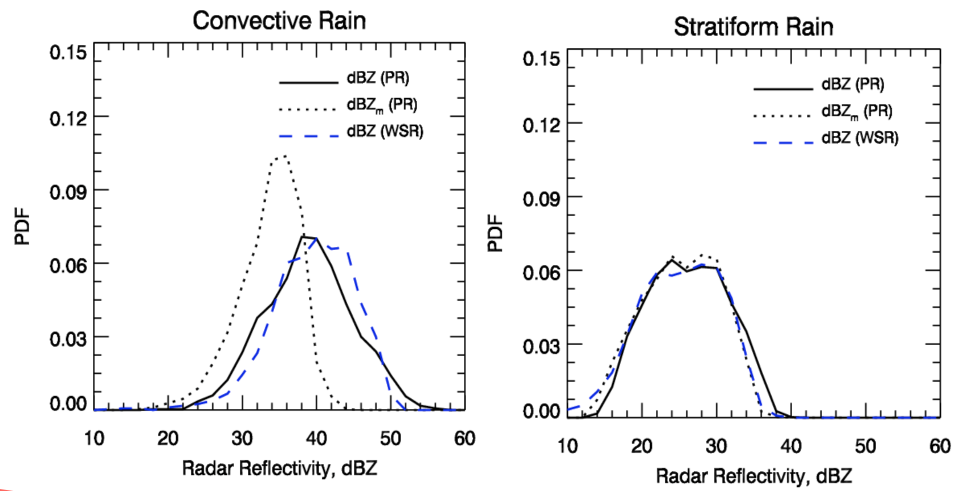
Synthesized Brightness Temperatures (R. Hood)

GMI channels encompass the range of frequencies present on constellation radiometers for GPM to serve as a "reference calibrator" for constellation radiometers



Courtesy of D. Hudak

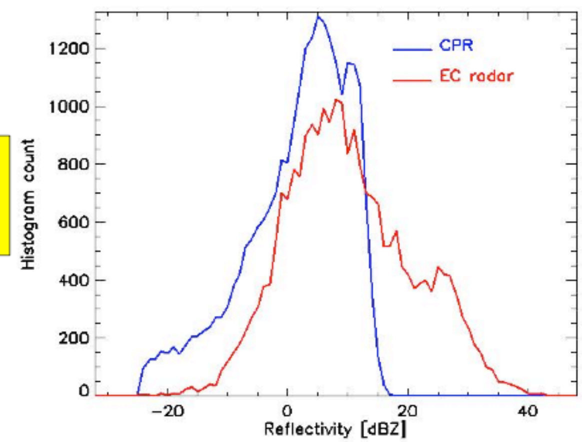
TRMM Ku-PR vs Melbourne WSR88



Meneghini et al.

CloudSat W-band CPR vs EC King City C-band Radar

Reflectivity distribution from 1456 profiles of precipitation from Sept. 2006 to April, 2007



3rd GPM GV Workshop, Buzios, Brazil, March 4-6, 2008

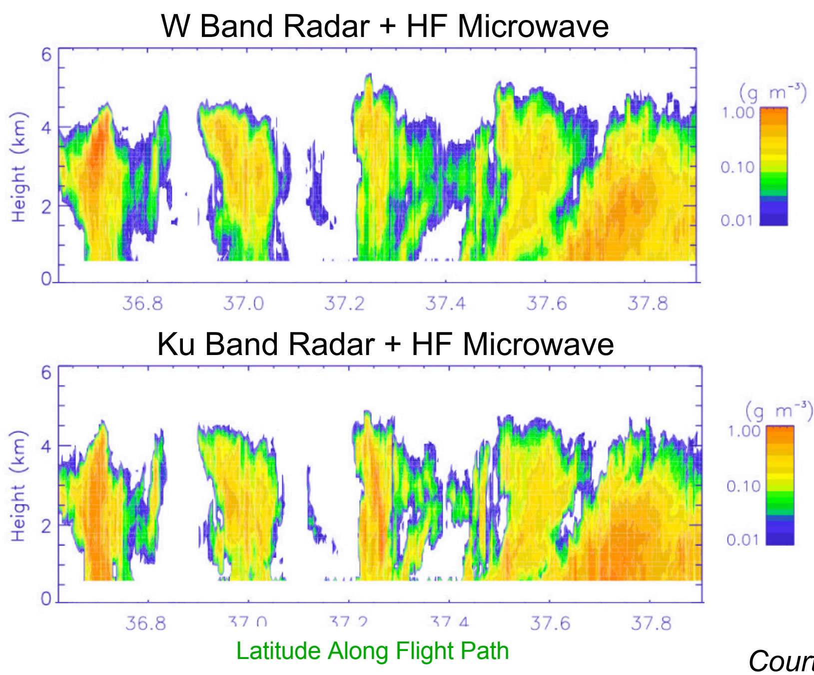
Environment Canada Environnement Canada Canada

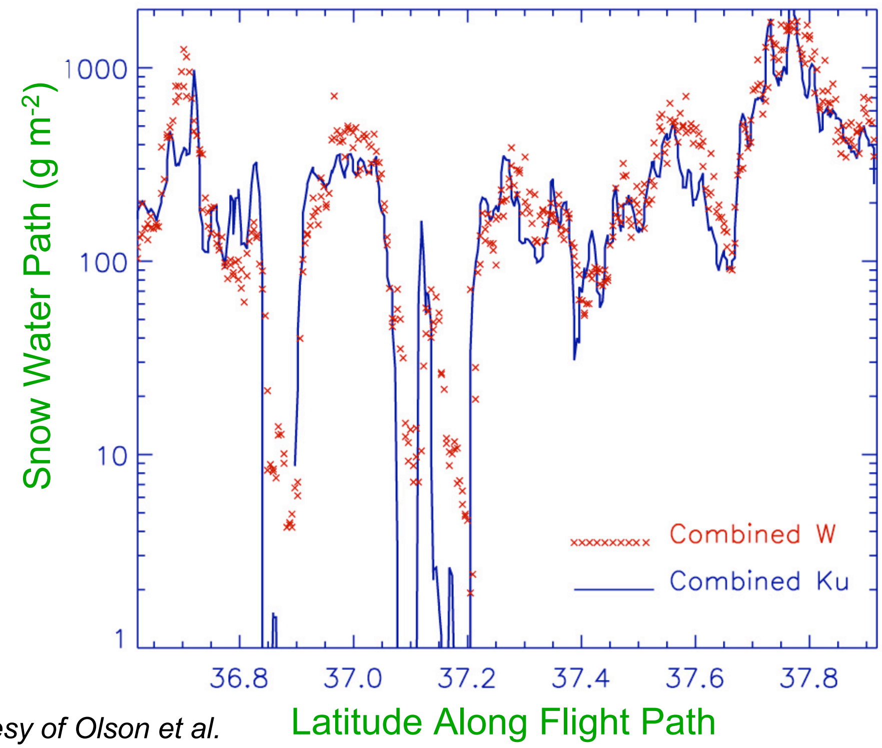
Synergy with CloudSat, EarthCare, & ACE

Microwave radiances can be sensitive to cloud water

Snow Retrieved from Airborne Radar & HF Radiometers over Wakasa Bay

Retrieved Snow Water Contents





Courtesy of Olson et al.

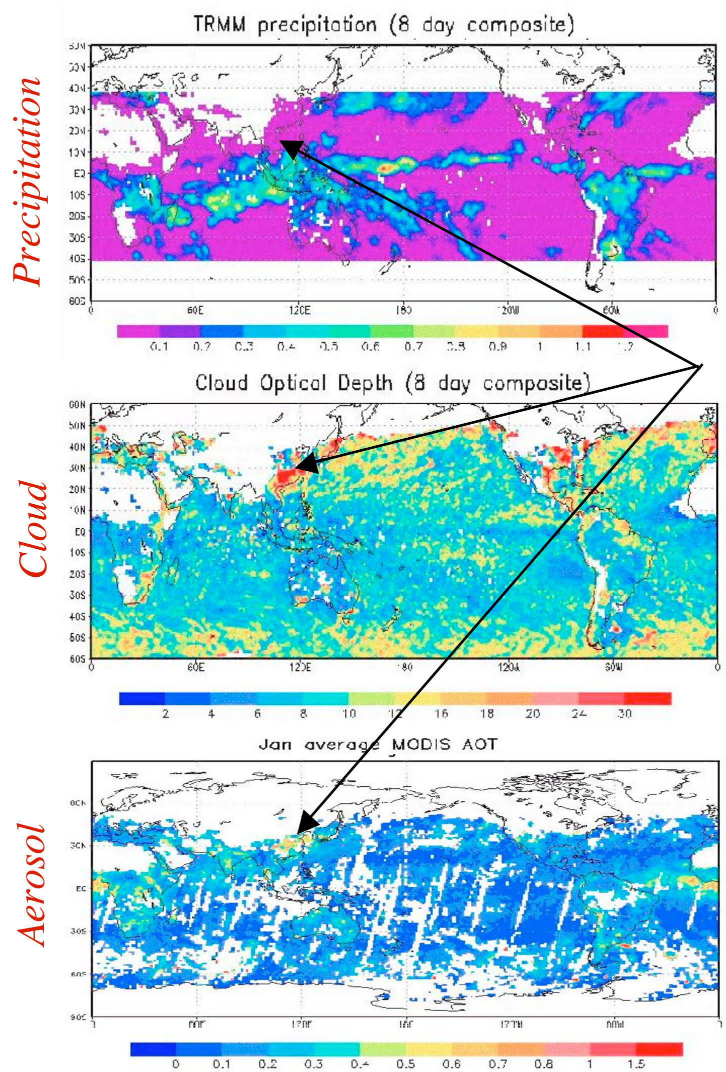
Either W-band (cloud radar) or Ku-band observations may be combined with HF passive microwave data (89 - 183 GHz) to obtain credible estimates of snow water contents.

Vertically-integrated snow water path estimated from W-band or Ku-band, combined with HF microwave, give similar results. Note that the higher minimum signal at Ku limits its sensitivity to very light snow.

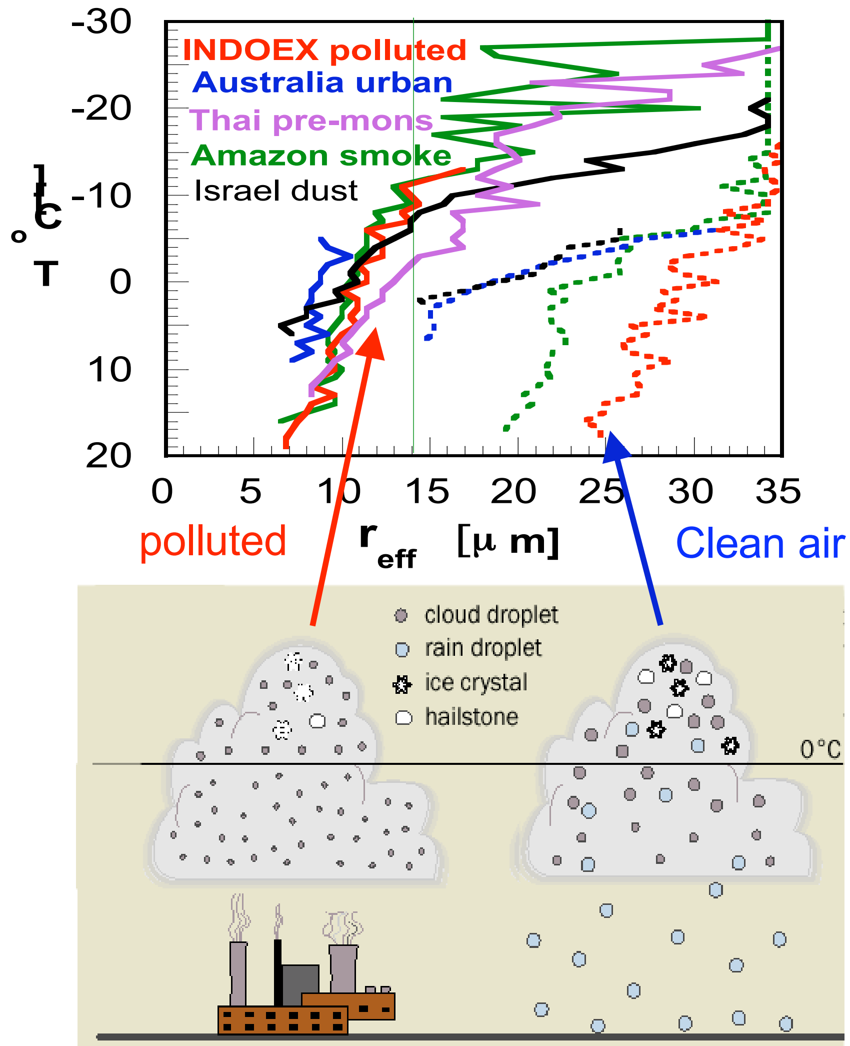
Synergy in improvements of satellite simulators for cloud and precipitation

Aerosol-cloud-precipitation interaction

Observational sorting of aerosol indirect effect

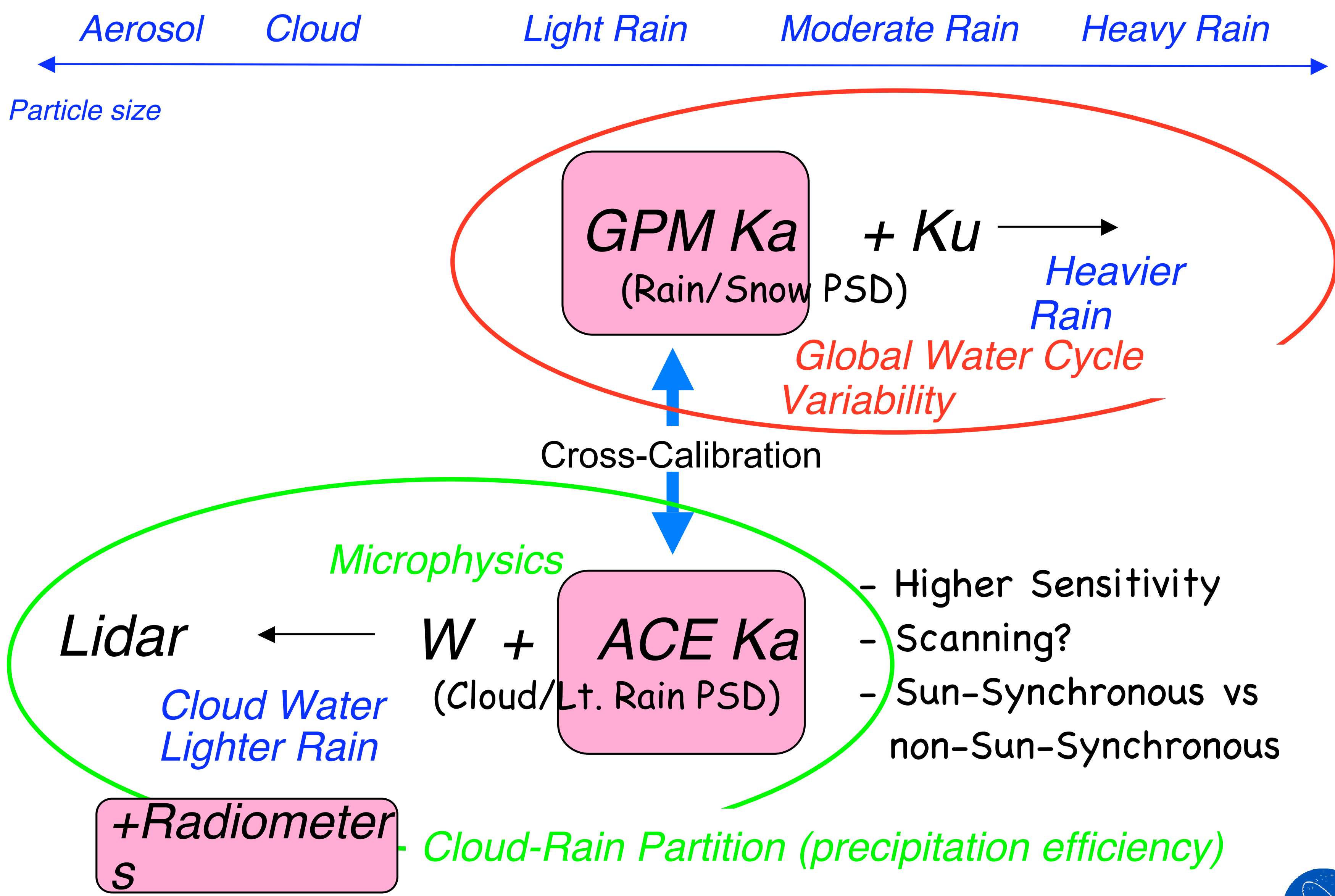


Z. Li (UMD)

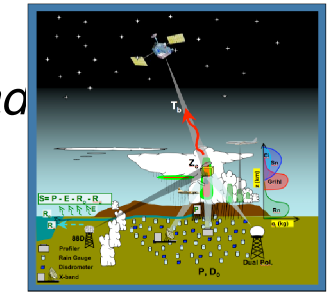


D. Rosenfeld

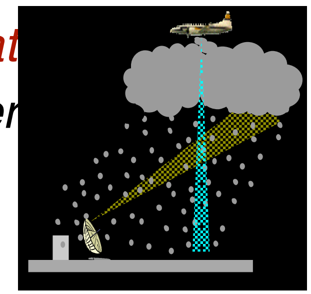
ACE-GPM Synergy



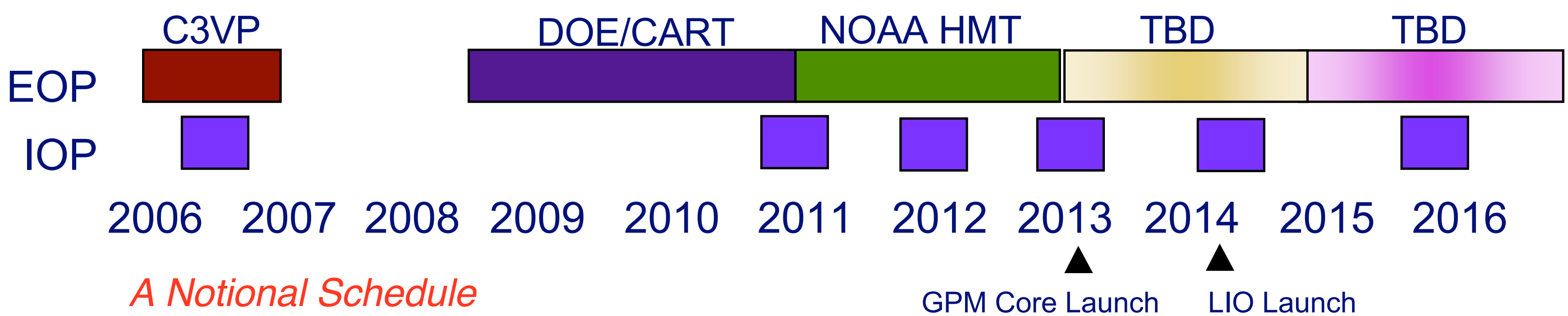
GPM Ground Validation for Pre-Launch Algorithm Development & Post-Launch Product Evaluation



- *Validation Network (statistical validation)*
  - *Leveraging off US national infrastructure of weather rad and rain gauges*
  - *Matched space-based observations to ground radars*
  - *Scalable to international partner sites*



- *Field Campaigns (physical validation & integrated hydrological validat*
  - *Extended Operational Periods (EOPs): observations over long per*
  - *Intensive Operational Periods (IOPs): enhanced intensive measurements including aircraft over shorter periods*



A Notional Schedule

Potential opportunities for leveraged collaboration with ACE pre-launch algorithm development